ARS 42-186
June 1971

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

A MECHANICAL DISPENSER FOR CONTROLLED INSECT RELEASE FROM AIRCRAFT

L. G. Schoenleber and H. R. Moffitt[1/]

SUMMARY

A dispenser for uniform metering of sterile adult codling moths into the airstream from an aircraft was designed and constructed to fit in a temperature controlled box. The equipment was developed for use with either rotary or fixed-wing aircraft.

PROBLEM

Effective distribution of sexually sterile insects is important in a codling moth control program. Sterile insects must be distributed over the entire crop area in a short period of time at regular intervals during the crop growing season. Codling moths are easily damaged and must be handled with extreme care to prevent loss of wing scales and other damage.

Wild codling moths have been controlled successfully by mating with sterile codling moths released from the ground and from boxes dropped from aircraft.[2/] Ground release is slow and difficult, and aerial drop of packaged insects leaves an accumulation of boxes on the ground that interferes with furrow irrigation.

Development of equipment and practices for continuous metering of unpackaged insects from an aircraft is needed to assist in fast and efficient coverage for control of codling moths in infested orchards.

1/ Agricultural engineer, Agricultural Engineering Research Division, and entomologist, Entomology Research Division, respectively, Agricultural Research Service, U. S. Department of Agriculture, Yakima, Washington.

2/ Boving, P. A., Winterfeld, R. G., Butt, B. A., and Deonier, C. E., A Box Ejector for Insect Distribution from a Helicopter, U. S. Dept. of Agriculture, Agricultural Research Service, ARS 42-156, 8 pp. 1969.

DESCRIPTION OF EQUIPMENT

The equipment included a dispenser, operator's control unit, mounting brackets with release tube, and a small portable refrigerator. Figures 1 and 2 show the general arrangement of the equipment when used with a fixed-wing aircraft.

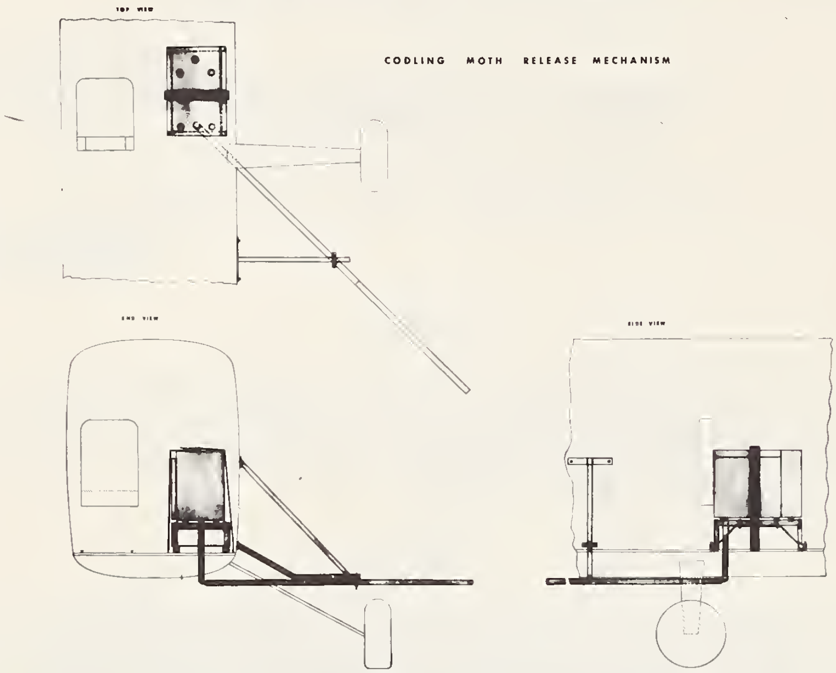


Figure 1. Position of insect release mechanism in aircraft.

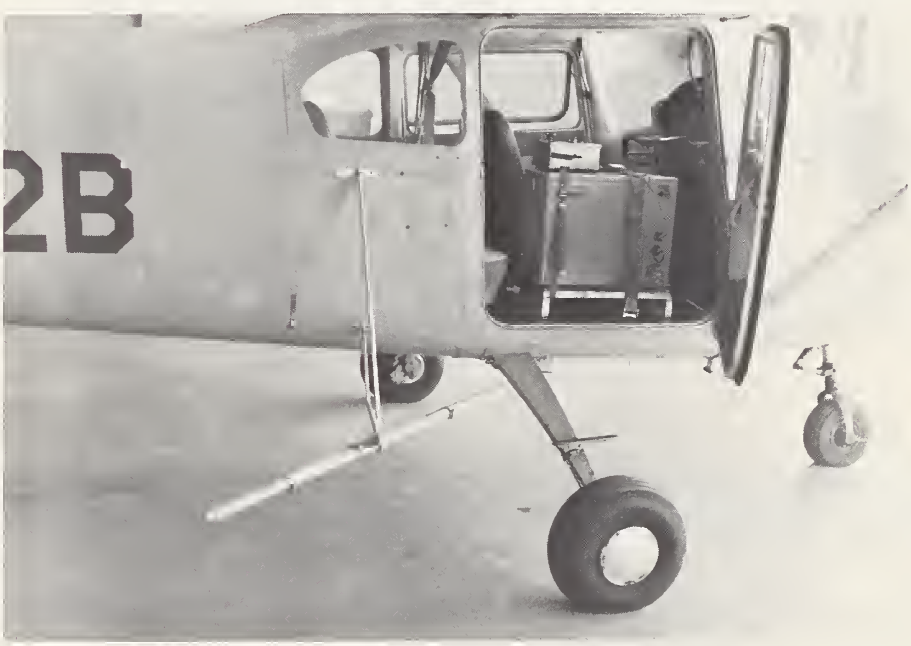


Figure 2. Insect release mechanism and dispensing tube mounted in a typical fixed-wing light aircraft.

A funnel was mounted under an opening at the bottom of the refrigerator and was connected to a tube that extends downward through the bottom of the aircraft. Clearance of one-half inch was provided between the funnel and the bottom of the refrigerator. The lower end of the tube, extending through the bottom of the fuselage, was bent at a right angle and projected approximately 1 inch horizontally into a larger tube (fig. 3). The larger

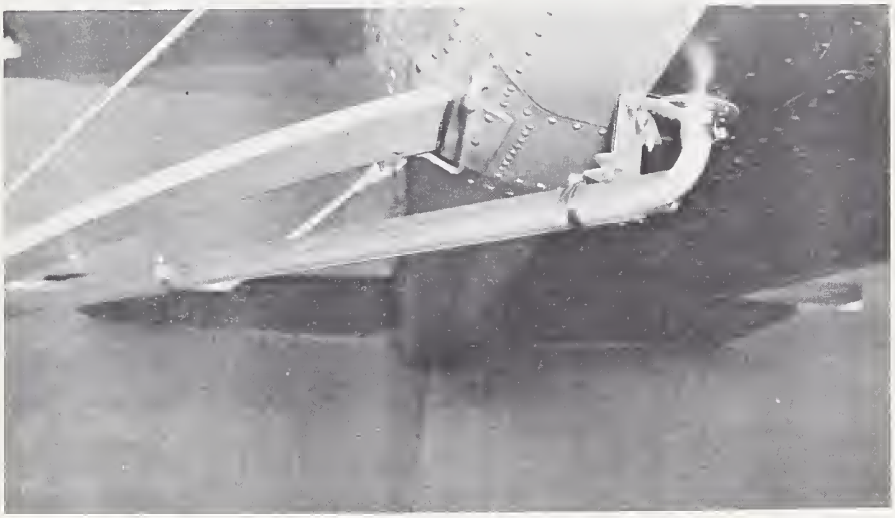


Figure 3. Attachment of insect dispensing tube to fuselage of aircraft. Vertical section of curved tube extends through the floor of the fuselage and is attached to a funnel under the refrigerator that contains the release mechanism.

horizontal tube extended away from the fuselage at a 45° angle to the centerline of the aircraft to a point behind the aircraft landing wheel. Air passing through the annular opening between the two tubes aspirated insects from the smaller tube and increased the speed of insects through the larger tube.

The equipment as mounted on a helicopter is shown in figure 4. The unit was strapped into a carrying basket. A hole in the basket directly below the outlet of the refrigerator let the insects fall through. No additional dispensing tubes were necessary for drops from a helicopter. A control box for the dispenser mechanism was located beside the pilot's seat. An electrical cord connected the dispenser to the operator's control box.

Figure 4. Insert release mechanism mounted on basket of helicopter.

The dispenser, control box, and refrigerator are shown in figure 5. The dispenser weighed 6½ pounds and is constructed to fit inside the refrigerator cooling compartment, a space 6-3/4 inches wide, 10-5/8 inches long, and 12 inches high (fig. 6).

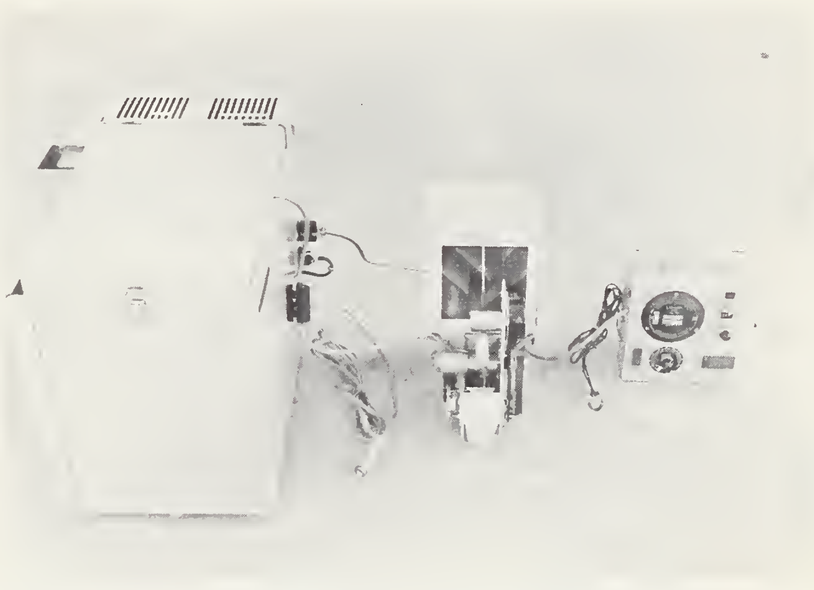


Figure 5. Refrigerator, insect dispenser, and control unit.

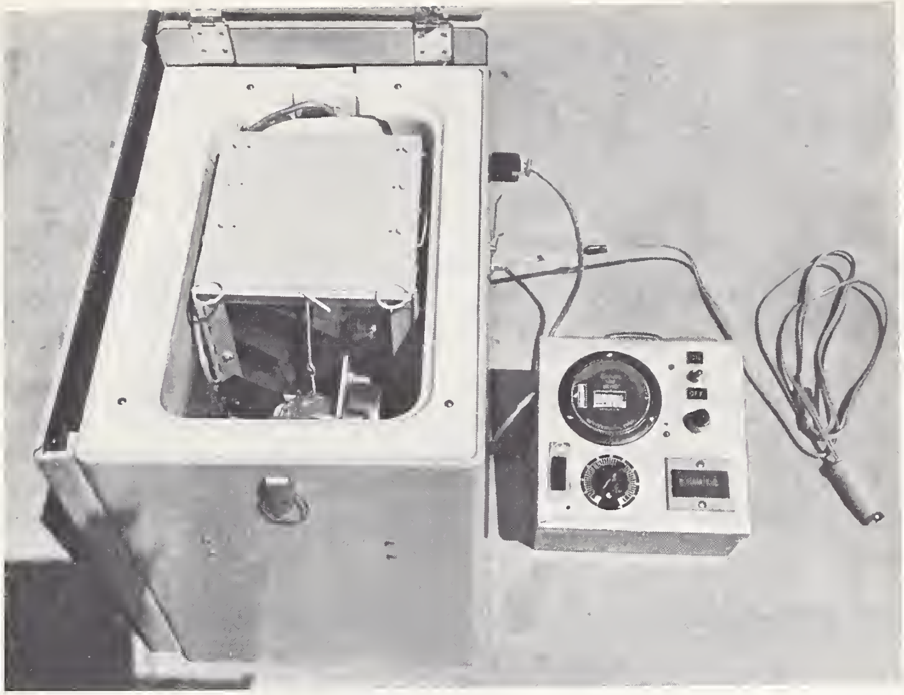


Figure 6. Refrigerator with lid open showing dispenser. Cord of operator's control unit plugs into receptacle on the refrigerator. Power cord for the system plugs into aircraft's electric system.

The dispenser had an insect holding container, a metering belt, an adjustable slide gate, a motor drive system, a rotating brush, and a solenoid operated gate. The insect holding container included deflector plates extending from two sides of the container (fig. 7). Because they were spaced 1-3/4 inches

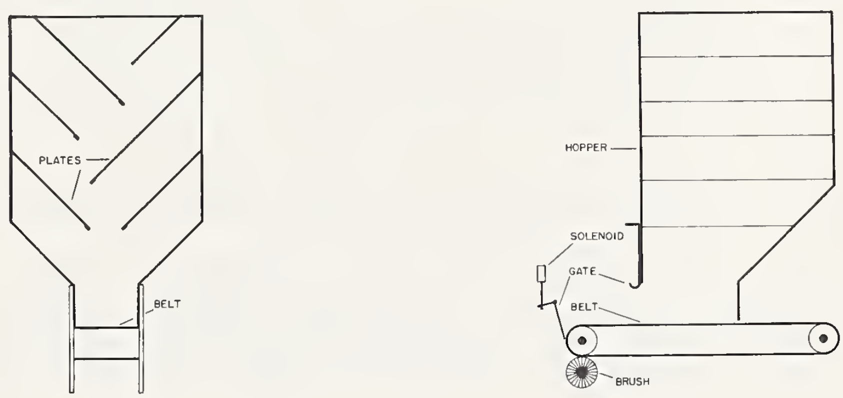


Figure 7. Arrangement of principal parts of insect hopper and dispensing mechanism.

apart and sloped at an angle of 45° from the horizontal, these plates minimized the load depth of insects upon each other. A plate mounted at a 45° slope formed the lower rear wall of the container above the belt. Belt exposure inside the container was 2 inches wide and 3 inches long.

The operator's control box included:

1. A switch to start and stop the motor driving the delivery belt. The same switch also controlled the solenoid-operated gate at the end of the belt and the counter and timer circuits.

2. A rheostat to control the speed of the belt drive motor.

3. A pilot light to indicate when the dispenser was operating.

4. A digital display for the counter that recorded the total linear movement of the feed belt.

5. A digital timer to indicate elapsed time of operation.

6. A switch to start and stop a blower which was mounted in the refrigerator on the dispensing equipment. This blower circulated cold air to assist in maintaining a uniform temperature in the box.

An electrical diagram of the dispensing equipment and controls is shown in figure 8.

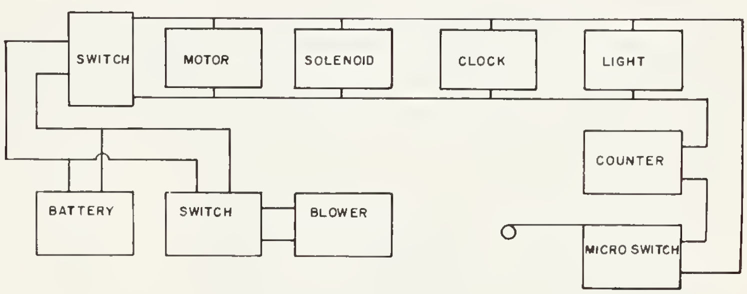


Figure 8. Electrical diagram of aerial release equipment.

The refrigerator, which weighed 42 pounds, operated on 115-volt, 60 cycle, alternating current as well as 12-volt direct current. It was modified by boring a 1-inch diameter hole in the bottom near one end for passage of the insects. A 1° F. temperature differential thermostat was installed to improve temperature control.

OPERATION AND PERFORMANCE

To minimize activity before release, the insects were held at a temperature of 34° to 38° F., both in the cold room at the rearing facility and while in the dispenser during transport. At these temperatures the insects were metered uniformly and did not cling to the dispenser.

The insects were loaded into the dispenser while in the cold room. The dispenser was then placed in the temperature regulated box for transportation to the field in the aircraft.

Operation of the dispenser was controlled by switches on the control box. When insects were to be dispensed, the pilot closed the main switch. This turned on the indicator light, started the belt drive motor, actuated the solenoid to hold the gate open, and started the counter and timer. To stop these operations, the pilot opened the operator's switch. When the gate solenoid de-energized, the gate closed automatically by gravity.

A separate switch for the blower was closed to circulate air inside the refrigerator during the time insects remained in the dispenser. It was then turned off.

Current requirements were 4.5 amperes for the refrigerator and 1.5 amperes for the dispenser.

The deflector plates inside the dispenser metered an even flow of insects to the belt and limited the weight of insects upon each other. The maximum depth of insects resting on each other was 3 inches.

When delivered through a round tube, insects moved along a spiral path. The spiral movement was negligible when a tube having a rectangular cross section was used.

The dispenser held approximately 75,000 adult codling moths. Adjustments on the dispenser permitted metering insects at rates ranging from approximately 1,000 to 17,500 per minute. Other metering rates could be obtained by changing the speed ratio of two pulleys. A nomograph shown as figure 9 was developed to aid in rapid adjustment of the dispenser. Acres covered per minute and insects released per minute were determined from the nomograph by selecting (1) aircraft ground speed in miles per hour, (2) swath width in feet, and (3) insects to be released per acre. Example: If a straight line is drawn with the aircraft speed of 100 m.p.h. used as one point and a swath of width of 50 feet used as the other point, the line intersects the scale of acres per minute at 10.1. Another line drawn between 10.1 on the scale of acres per minute and 400 on the scale of insects released per acre, intersects the scale of insects released per minute at 4,040.

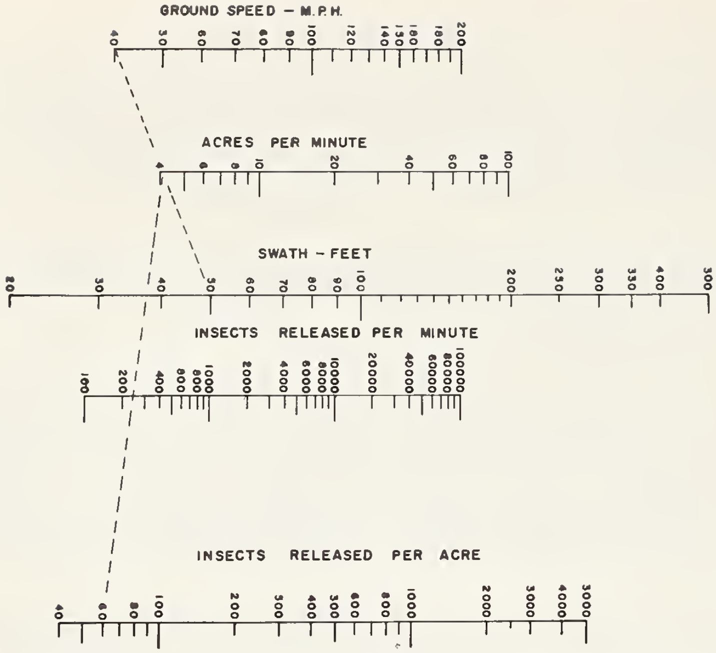
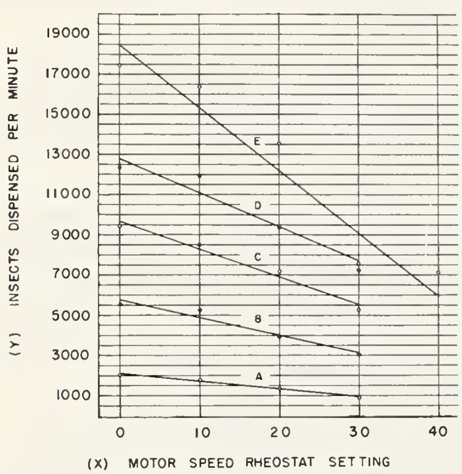


Figure 9. Nomograph relating factors affecting rate of release of codling moth.

The relationship of the dispenser metering rate (insects per minute) with gate opening and motor drive speed is shown in figure 10. Example: For a



(A) .25 INCH GATE OPENING
Y = 2075 − 38 X CORRELATION COEFFICIENT r = .990

(B) .50 INCH GATE OPENING
Y = 5752 − 87 X CORRELATION COEFFICIENT r = .975

(C) .75 INCH GATE OPENING
Y = 9662 − 139 X CORRELATION COEFFICIENT r = .897

(D) 1.00 INCH GATE OPENING
Y = 12791 − 172 X CORRELATION COEFFICIENT r = .940

(E) 1.25 INCHES GATE OPENING
Y = 18450 − 314 X CORRELATION COEFFICIENT r = .970

Figure 10. Motor rheostat settings versus insects dispensed, for various openings of metering gate.

0.5-inch gate opening, Y = 5,752 - 87X, where Y = metering rate and X = motor drive speed adjustment. This means that to release 4,040 insects per minute would require a gate opening of 0.5 inch and a motor rheostat setting of 19.7. The same reading may be obtained directly from the straight line of the graph. A formula and correlation coefficient are shown for each of the gate openings. The amount of insects dispensed per revolution of belt drive pulley was constant within $\pm$ 3 percent for each gate opening, regardless of belt speed (fig. 11). The formula Y = 1,430X - 166 and

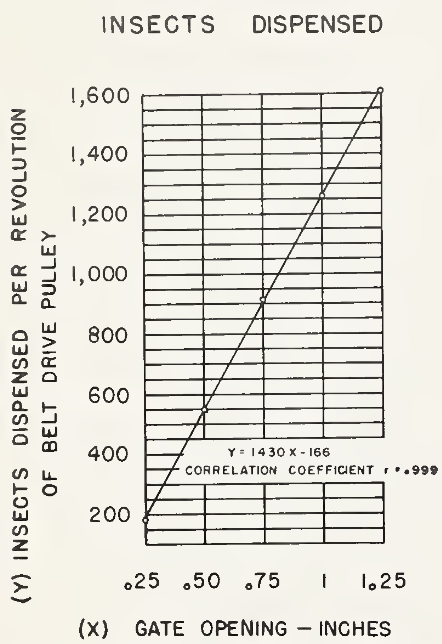


Figure 11. Codling moths released per revolution of belt drive pulley, for various openings of metering gate.

correlation coefficient r = 0.999 show the relationship.

PRECAUTIONS

Direct current voltage to the dispenser drive motor should be kept constant to maintain a uniform motor speed and insect dispensing rate. One possible way to accomplish this would be to supply the dispenser drive motor through a D.C. voltage regulator that maintains constant output voltage with varying input.

Positive pressure of about 0.006 p.s.i. should be maintained in the aircraft cabin to ensure effective movement of air through the funnel and delivery tube. This was obtained by opening the forward vents of the aircraft cab.

Cold air leakage from the refrigerator through the hole in the bottom for releasing insects added to the cooling load of the refrigerator. Closing the opening when insects are not being dispensed would minimize cold air leakage.

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
BELTSVILLE, MARYLAND 20705

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF
AGRICULTURE

U.S.MAIL